Biological Evaluation of
Hemlock Woolly Adelgid and Elongate Hemlock Scale
at
Catoctin Mountain Park,
Thurmont, Maryland

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ABSTRACT

In the spring of 2004, personnel from the USDA Forest Service, Northeastern Area, Forest Health Protection, Morgantown Field Office, conducted surveys to evaluate hemlock woolly adelgid (HWA), *Adelges tsugae*, and elongate hemlock scale (EHS), *Fiorinia externa*, population densities in the Hemlock Road, Bear Branch Creek, and Camp Round Meadow areas at Catoctin Mountain Park (CMP), and to assess the need for treatment. Current populations are high enough to impact tree health. It is recommended that Catoctin Mountain Park ground spray infested trees at Camp Round Meadow with a horticultural oil for control of the HWA and the EHS.

INTRODUCTION

HEMLOCK WOOLLY ADELGID

Adelgids are small, soft-bodied insects that feed primarily on plant sap. The family is divided into two genera: *Adelges* and *Pineus*. The members of this family feed exclusively on conifers. There are six species of *Adelges* that occur in North America, of which only one is native (Montgomery 1999), the Cooley spruce gall aphid (*Adelges cooleyi*). This adelgid occurs coast to coast in northern North America. Its primary hosts are recorded as white (*Picea glauca*), blue (*Picea pungens*), Sitka (*Picea sitchensis*), and Engelmann (*Picea engelmannii*) spruce (Baker 1972). It has an alternate host, Douglas fir (*Pseudotsuga menziesii*). There are 10 species of *Pineus* that occur in North America, of which seven are native. Four of these, the pine bark adelgid (*Pineus strobi*); the pine leaf adelgid (*P. pinifoliae)*; the red spruce adelgid (*P. floccus*); and the spruce gall adelgid (*P. similes*) seem to be indigenous to eastern North America (Drooz 1989, Montgomery 1999). These species attack eastern white pine (*Pinus strobus*), red spruce (*Picea rubens*), and black spruce (*Picea mariana*) but seldom cause extensive damage (Drooz 1989, Montgomery 1999). Little is known about the population dynamics, ecological role, or the predator and parasite complex associated with these native adelgids.

Native to Asia, the hemlock woolly adelgid (*Adelges tsugae)*, is a pest of eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*T. caroliana*) (Onken et al. 1999) both of which are considered highly susceptible to the adelgid, with no documented resistance (Bentz et al. 2002). The latter tree species is found only in the southern region of the Appalachian Mountains (Onken et al. 1999). The HWA is currently established in 16 Eastern States from Georgia to Maine, and tree decline and mortality have increased at an accelerated rate since the late 1980s. For example, in the Shenandoah National Park (SNP), hemlock crown health has declined since the early 1990s. In 1990, greater than 77 percent of the hemlocks sampled were in a "healthy" condition; by 1998, less than 10 percent were in a "healthy" condition (Akerson and Hunt 1998). In another study at SNP, tree mortality significantly increased from an initial 8 percent in 1990 to nearly 50 percent in 2000 (Bair 2002). In New Jersey less than 13 percent of stands surveyed in 1991 remain healthy. Twelve years after initial HWA infestations, tree mortality has

reached more than 90% in some New Jersey hemlock stands (Mayer et al 2002). Similar HWA-caused impacts are also affecting hemlock stands at CMP.

The hemlock woolly adelgid is parthenogenetic (an all-female population with asexual reproduction) that has six stages of development: the egg, four nymphal instars, and the adult, and two generations a year on hemlock; each adult adelgid can produce 50 to 300 eggs in her lifetime (McClure 1989, 1995). The hemlock woolly adelgid also has a winged form that is produced by the spring generation. This form must complete part of its life cycle on spruce. The apparent lack of a suitable spruce host for this form in eastern North America results in a substantial loss of adelgids each year (McClure 1992a). Although natural mortality in HWA populations is commonly between 30 to 60 percent (McClure 1989, 1996), the reproduction potential of this insect remains high. Other mortality is generally attributed to two likely causes: 1) an extended period of cold temperatures or rapid temperature changes that coincides with a susceptible period of development for the adelgid, and/or 2) a sufficient loss in the nutritional quality and quantity of the food source, which is associated with the decline in health and vigor of the host tree (McClure 1996, Onken et al. 1999). Adelgid feeding can kill a mature tree in about 5 to 7 years (McClure et al. 2001). This tiny insect (~ 1 mm) feeds on all life stages of hemlock, from seedling to mature, old growth tree. The first instar nymphs, called crawlers, search for suitable sites at the base of the hemlock needles, and insert their feeding stylets into the young hemlock twigs and are committed to that feeding site throughout the remainder of its development. The stylet bundle is more than three times the length of the insect and penetrates deep within the plant tissues. HWA does not deplete nutrients directly by feeding on the sap, but rather by depleting the food reserves from the tree's storage cells (McClure et al. 2001). Dispersal and movement of HWA during its egg and mobile first instar stages is associated with wind, birds, deer, and other forest dwelling mammals. Humans also move the adelgid during logging and recreational activities and movement of infested nursery stock (McClure 1995). Natural enemies capable of maintaining low-level HWA populations are nonexistent in eastern North America (Van Driesche et al. 1996, Wallace and Hain 1998).

HWA was first reported in the western U.S. in the 1920s (Annand 1924, McClure 2001). HWA populations on western tree species, including western hemlock (*Tsuga heterophylla*) and mountain hemlock (*T. mertensiana*), appear to be innocuous; these tree species are believed to be resistant because little damage has been reported (McClure 2001). Unfortunately, both these trees are of limited value for hybridization and planting due to their poor adaptation to the east coast environment (Bentz et al. 2002). In the East, HWA was first reported in 1951 near Richmond, Virginia. It was considered to be more of an urban landscape pest and was controlled using a variety of insecticides applied with ground spraying equipment. Observations of the adelgid were periodically reported in several Mid-Atlantic States in the 1960s and 1970s but it was not until the 1980s that HWA populations began to surge and spread northward to New England at an alarming rate. By the late 1980s to early 1990s, infestations of HWA were reported to be causing extensive hemlock decline and tree mortality in hemlock forests throughout the East (McClure 2001).

SCALE INSECTS

There are several scale insects that affect hemlocks in the eastern United States. The more common ones belong to the family *Diaspididae*, or armored scales. Armored scales form a protective cover that is unattached to the body. The hemlock scale, *Abgrallaspis ithacae,* is native to the United States and is probably present throughout the East. *A. ithacae* is generally not a significant pest (Johnson and Lyon 1988). The hemlock scale has also been reported on fir (*Abies* species) and spruce (*Picea* species) (Drooz 1989). Two exotic scales that attack the eastern and Carolina hemlock are the elongate hemlock scale, *Fiorinia externa*, and the short needle evergreen scale (a circular hemlock scale), *Nuculaspis tsugae* (Johnson and Lyon 1988, McClure 2002a). Native to Japan, the short needle evergreen scale and the elongate hemlock scale were first reported in the United States, in 1910 and 1908, respectively. The short needle evergreen scale is now known to occur in Connecticut, Maryland, New Jersey, Rhode Island, and New York (McClure 2002a), and its hosts other than hemlock include fir, cedar (*Cedrus* species), spruce and yew (*Taxus* species) (Drooz 1989). The EHS has been found in the District of Columbia and in nine states from Virginia to southern New England and west to Ohio (McClure 2002b). The EHS is known to occur on species of spruce, fir, yew and hemlock (Drooz 1989). Spruce and fir tend to be even more susceptible than hemlock, although it has not yet spread into the natural ranges of these other native conifers. Circular hemlock scale is far less abundant and generally out competed by the elongate hemlock scale (McClure 2002a).

The EHS completes two generations each year in the Southern and Mid-Atlantic States, but usually only one in the Northeast. Its life stages are broadly overlapping everywhere, and crawlers can be found throughout the spring and summer. Crawlers are the only stage capable of dispersing and establishing new infestations. Dispersal between trees is primarily by wind and birds. Females have three stages of development after the egg stage, while males have five. During the first and second instar stages, both sexes settle beneath the thin waxy cuticle on the lower surface of the youngest hemlock needles and begin to feed. While in these stages, both sexes secrete a cover around itself as it grows. After the first and second nymphal instar stages, the female then molts into the adult feeding stage, while the male molts into a non-feeding prepupa and spins a cocoon, where it pupates before it emerges as an adult. The adult male mates with the female and dies soon thereafter without feeding. The adult female lays about 20 eggs within her cover. The EHS usually overwinters, either as an egg or as an inseminated adult female. When the crawlers hatch, they exit through a small opening at the posterior end of the cover (McClure 2002b).

The EHS attacks the underside of the hemlock needles by removing fluids from the mesophyll cells through piercing and sucking mouthparts. Scale populations build slowly on healthy trees, but much more quickly on stressed ones. Feeding by HWA has been shown to affect nutrient dynamics in hemlock stands (Jenkins et al. 1999) and this could feasibly reduce tree vigor sufficiently to allow scale insects such as EHS to become established and explode in population size (Danoff-Burg and Bird 2002). Mixed infestations of EHS and HWA can greatly hasten hemlock decline. Feeding by EHS causes foliage to turn yellow and drop prematurely. Dieback of major limbs, which

usually progresses from the bottom of the tree upwards, usually occurs after scale density reaches about 10 individuals per needle. Trees often die within the next 10 years, but some survive longer in a severely weakened condition with only a sparse amount of foliage at the very top of the crown. These weakened trees have very little chance of recovery and often fall victim to secondary pests, such as hemlock borer and *Armillaria* root disease or readily broken and thrown by wind (McClure 2002b).

HEMLOCK IMPORTANCE

Eastern hemlock is an extremely shade tolerant tree species, capable of surviving for as long as 350 years underneath a shaded forest canopy (Quimby, 1996). It is a slow-growing long-lived tree. It may take 250-300 years to reach maturity and may live for 800 years or more (Godman and Lancaster 1990). Eastern hemlock forests create distinctive mircroclimates and provide important habitat for a variety of wildlife, such as birds, fish, invertebrates, amphibians, reptiles and mammals. In the Northeast, 96 bird and 47 mammal species are associated with hemlock forests at some point during their life (Yamasaki et al. 2000).

Eastern hemlock is a component of the forest on more than 200 acres at CMP. These forests can be found primarily along the Big Hunting Creek and Owens Creek areas. At Big Hunting Creek, hemlocks trees play a vital role in the creek ecology. The hemlock canopy provides shade which helps cool the water temperature in the summer. This is critical for the survival of cold-water organisms, like the wild brook and brown trout found there. If hemlock is lost in these areas, long-term degradation to the watershed is likely because tree regeneration of any species will be very limited due to browse impact from high-densities of the white-tailed deer. Loss of vegetation, bank erosion and sedimentation will further degrade water quality and aquatic habitats. Catoctin Mountain Park is the only park within the National Capital Region that has a population of native brook trout (USDI 2003). It is Maryland's first CATCH AND RETURN trout stream. The survey area at Bear Branch Creek is part of the Big Hunting Creek area. Groups of individual hemlock trees also occur around some of the recreational and administration buildings, such as the Camp Round Meadow and Visitor Center areas. Hemlock trees contribute to the ecological, aesthetic and recreational values of the park.

HWA AND EHS HISTORY AND DECLINING HEMLOCK HEALTH CONDITIONS AT CATOCTIN MP

HWA was first noticed at Catoctin MP more than 10 years ago. In 2000, building populations of EHS was first noticed in the Round Meadow area and Cunningham Falls State Park, adjacent to CMP. Virtually all of the large eastern hemlock trees have become infested and are currently in poor health or dead. Surveys indicate that all hemlock stands are currently infested with some level of HWA and/or EHS populations and 50% of the trees are either dead or in severe decline (USDI 2003).

In 2001, horticultural oil was applied on individual trees at Camp Round Meadow to control HWA and EHS. In 2002, fifty hemlock trees in the Camp Round Meadow and

Bear Branch Creek areas received trunk injections of a systemic insecticide imidacloprid (Pointer®), at 5 percent active ingredient to control HWA.

METHODS

Hemlock trees (> 6" dbh) were randomly selected for inspection within the survey areas. An assessment of tree vigor, branch tip dieback, crown position, dbh, and HWA and EHS population densities was conducted of each tree. Branch samples were collected and returned to the lab to evaluate viability of HWA populations and degree of winter mortality.

HWA and EHS infestation levels were designated as heavy, moderate, light or not infested based on the criteria listed below:

HWA – Based on the percentage of tips with adelgid present per 30 centimeters of hemlock twig length:

Heavy (H) = >50% infested
Moderate (M) = 25% to 50% infested
Light (L) = <25% infested
None (N) = not infested

EHS – Visual estimate of scale density on needles within a 30 centimeter length of hemlock branch:

Heavy = >1 scale/needle on average
Moderate = 1/needle on average
Light = <1/needle on average
None = not infested

Tree health assessments were also conducted of the trees sampled above. Visual estimates of crown conditions were used to characterize general health and tree vigor using the following criteria:

Healthy (H) = tree appears to be in reasonably good health: less than 10% branch or twig mortality, discoloration, or dwarfed leaves present
Light Decline (LD) = branch mortality, twig dieback, foliage discoloration, or dwarfed leaves present on 10-25% of the crown
Moderate Decline (MD) = branch morality, twig dieback, foliage discoloration or dwarfed leaves on 26-50% of crown
Moderate-Severe Decline (MS) = branch morality, twig dieback, foliage discoloration or dwarfed leaves on 51-75% of crown
Severe Decline (SD) = more than 75% of the crown with branch mortality, dieback, discoloration or leaf dwarfing, but foliage still present indicating that the tree is alive

RESULTS

The survey areas are represented in Figure 1. The results of the survey are summarized in Table 1. Hemlock woolly adelgid infestations are light to none at the Hemlock Road and Bear Branch Creek areas and are generally light to moderate at the Camp Round Meadow area. HWA winter mortality at Catoctin Mountain Park averaged 83 percent.

Hemlock trees at the Hemlock Road area are generally in severe decline. Trees at the Bear Creek and Camp Round Meadow areas are mostly in moderate decline with a few trees in a further state of decline.

Elongate hemlock scale infestations are heavy at the Hemlock Road and Bear Branch Creek areas and are generally light in the Camp Round Meadow area.

Figure 1. Hemlock woolly adelgid and elongate scale survey locations at Catoctin Mountain Park, Thurmont, MD - Round Meadow, Hemlock Road and Bear Branch areas - Spring 2004.

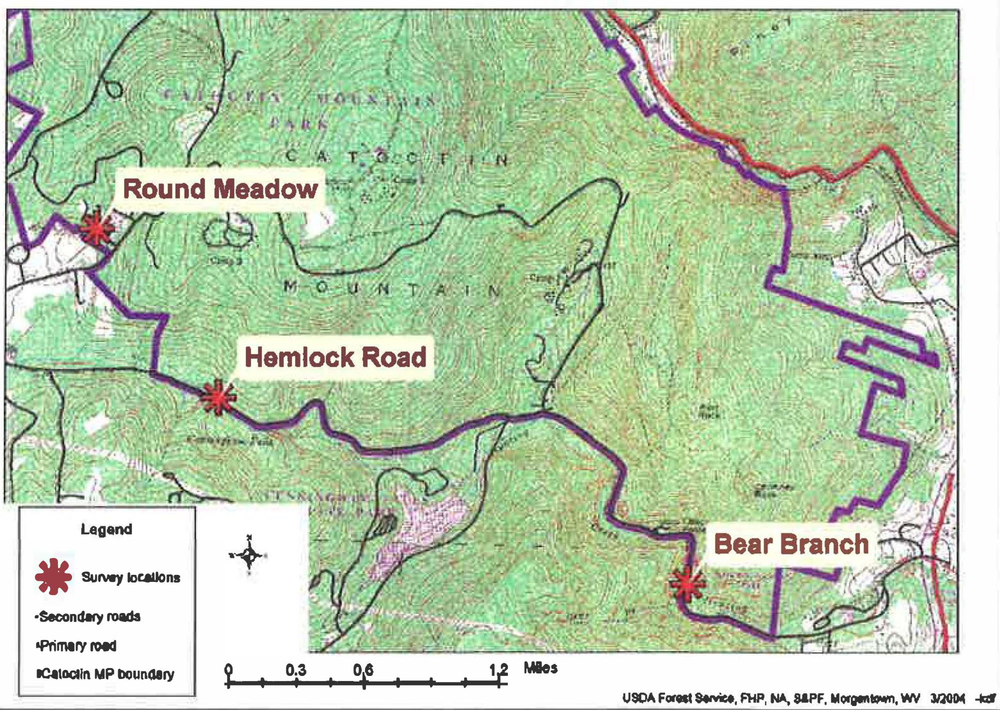

Table 1. *Summary of the hemlock woolly adelgid and elongate hemlock scale survey results for the Hemlock Road, Bear Branch Creek, and Camp Round Meadow areas at Catoctin Mountain Park, February 2004.*

#	LOCATION	DBH[1]	CROWN POSITION[2]	HWA INFEST LEVEL[3]	ELONGATE SCALE INFEST LEVEL[4]	DEAD TIP %[5]	VIGOR[6]
1	HEMLOCK ROAD	12	I	NONE	HEAVY	3	SD
2	HEMLOCK ROAD	12	I	NONE	HEAVY	11	SD
3	HEMLOCK ROAD	14	CD	NONE	HEAVY	11	SD
4	HEMLOCK ROAD	14	CD	NONE	HEAVY	21	SD
5	HEMLOCK ROAD	10	I	NONE	HEAVY	4	SD
6	HEMLOCK ROAD	16	I	NONE	HEAVY	13	SD
7	HEMLOCK ROAD	9	S	NONE	HEAVY	18	SD
8	HEMLOCK ROAD	14	I	NONE	HEAVY	17	SD
9	HEMLOCK ROAD	20	D	NONE	HEAVY	7	SD
10	HEMLOCK ROAD	14	CD	NONE	HEAVY	8	SD
11	HEMLOCK ROAD	12	S	LIGHT	HEAVY	15	MS
1	BEAR BRANCH CREEK	10	S	NONE	HEAVY	5	M
2	BEAR BRANCH CREEK	18	CD	NONE	HEAVY	15	M
3	BEAR BRANCH CREEK	8	S	LIGHT	HEAVY	36	M
4	BEAR BRANCH CREEK	10	S	LIGHT	HEAVY	53	MS
5	BEAR BRANCH CREEK	12	I	NONE	HEAVY	26	M
6	BEAR BRANCH CREEK	8	S	NONE	HEAVY	31	M
7	BEAR BRANCH CREEK	12	I	NONE	HEAVY	18	M

Table 1. -Continued

#	LOCATION	DBH[1]	CROWN POSITION[2]	HWA INFEST LEVEL[3]	ELONGATE SCALE INFEST LEVEL[4]	DEAD TIP %[5]	VIGOR[6]
8	BEAR BRANCH CREEK	10	S	NONE	HEAVY	30	M
1	ROUND MEADOW	10	OG	LIGHT	LIGHT	0	M
2	ROUND MEADOW	10	OG	MODERATE	LIGHT	12	M
3	ROUND MEADOW	11	OG	LIGHT	LIGHT	7	M
4	ROUND MEADOW	10	OG	LIGHT	LIGHT	7	M
5	ROUND MEADOW	8	OG	LIGHT	LIGHT	12	MS
6	ROUND MEADOW	8	OG	HEAVY	LIGHT	61	MS
7	ROUND MEADOW	8	OG	LIGHT	LIGHT	37	MS
8	ROUND MEADOW	8	OG	MODERATE	LIGHT	12	MS
9	ROUND MEADOW	10	OG	LIGHT	LIGHT	60	MS
10	ROUND MEADOW	10	OG	LIGHT	NONE	20	MS
11	ROUND MEADOW	12	OG	LIGHT	LIGHT	7	M
12	ROUND MEADOW	12	OG	NONE	LIGHT	12	M
13	ROUND MEADOW	8	OG	HEAVY	LIGHT	0	M
14	ROUND MEADOW	10	OG	MODERATE	LIGHT	58	MS
15	ROUND MEADOW	8	OG	MODERATE	LIGHT	0	M

[1]-DBH= estimated tree diameter at breast height to nearest inch

[2]-Crown position: D=dominate, CD=co-dominate, I=intermediate, S=suppressed, OG=open grown

[3]-Percentage of tips with adelgid present per 30 centimeters (cm) of hemlock twig length: Heavy (>50% infested), Moderate (25-50% infested), Light (<25% infested), None (not infested)

[4]-Scale presence based on visual estimates from 30 cm length of hemlock branch: HEAVY (>1scale/needle on average), MODERATE (1 scale/needle on average), LIGHT (<1scale/needle on average), NONE = (not infested)

[5]-Precentage of dead tips per 30 centimeters of hemlock twig length

[6]- Vigor = Tree crown health:

Healthy = tree appears to be in reasonably good health: less than 10% branch or twig mortality, discoloration, or dwarfed leaves present

Light Decline = branch mortality, twig dieback, foliage discoloration, or dwarfed leaves present on 10-25% of the crown

Moderate Decline = branch morality, twig dieback, foliage discoloration or dwarfed leaves on 26-50% of crown

Moderate-Severe Decline = branch morality, twig dieback, foliage discoloration or dwarfed leaves on 51-75% of crown

Severe Decline = more than 75% of the crown with branch mortality, dieback, discoloration or leaf dwarfing, but foliage still present indicating that the tree is alive

DISCUSSION

Hemlocks throughout the park have been severely stressed over the past decade as a result of heavy infestations of HWA and EHS and drought. Virtually all hemlocks observed during this evaluation are in a moderate to severe state of decline. This includes the hemlock trees that received trunk injections of imidacloprid (Pointer®) in 2002.

HWA population densities throughout the park are generally low as a result of the declining tree health. The absence of new growth on branch tips has reduced food quantity and nutritional quality necessary for building populations of adelgids. In the absence of EHS or other stressors such as drought, some hemlocks would be expected to put out a flush of new growth. However, the additional stress caused by EHS will likely preclude the recovery of those hemlocks that have heavy scale infestations.

EHS populations range from light to heavy at CMP. Healthy hemlocks can typically sustain moderate densities of EHS but are often overwhelmed when attacked trees are already stressed. Population densities fluctuate periodically depending on the severity of winters, but often rebound following such events.

Consequently, impacts to hemlock resources throughout CMP will likely increase as more hemlocks succumb to these insects, which in turn will impact the associated habitat.

Management Considerations

Management options for preserving hemlock stands at CMP are very limited due to the biology and feeding behavior of HWA and EHS, pest population densities, site conditions (i.e. proximity to streams), poor tree health (reduced ability to translocate systemic insecticides), and limited chemical and application technology currently available.

Aerial spray using horticultural oil or insecticidal soap is not an effective treatment because it fails to provide the needed "saturation" coverage necessary to ensure the insecticide adequately covers the insect. Aerial spraying with more toxic insecticides (e.g. malathion or diazinon) would have very significant, unacceptable impacts on a wide range of non-target insects and other animals and limited control benefits (Evans 2000). Application of insecticides using ground spraying equipment is limited to areas accessible to heavy hydraulic spray equipment and areas where over spray or run off would not contaminate streams or ponds. There are no known pheromones for either HWA or EHS. Successful establishment of predators of HWA such as *Sasajiscymnus tsugae* (formerly *Pseudoscymnus tsugae*) requires a viable and healthy population of adelgids which ironically is linked to healthy hemlocks, neither of which is present within the park. Tree injections using systemic insecticides such as imidacloprid has not proven to be effective at controlling HWA when trees are in moderate to severe decline. Soil injection and soil drench using imidacloprid has been demonstrated effective at controlling HWA but not EHS.

Systemic Insecticides

Several types of systemic insecticides can be injected (e.g. imidacloprid, bidrin or Metasystox-R®) or implanted (e.g. acephate) into hemlock trees, and another (Merit®) can be applied as a soil drench or injected into to the soil around hemlock trees. These insecticides are absorbed and transported by the vascular system of the tree to feeding adelgids and will effectively suppress HWA populations (Doccola et al. 2003, Webb et al. 2003, Evans 2000, Steward and Horner 1994, McClure 1992a). Soil injection can cause leaching of the insecticide into the soil profile and groundwater (McAvoy et al. 2002) and should not be used in areas where this is a concern, such as along creeks. Of the trunk injections systemic insecticides available only imidacloprid under the trade names Pointer®, IMA-jet® and Imicide® are currently labeled for tree injection for the control of adelgids. Although imidacloprid is labeled for controlling scale pests, it has not proven to be effective on EHS. Acephate controls adelgids and scale pests and is available as a trunk implant under the trade name ACECAP®.

Imidacloprid

Imidacloprid is a relatively new insecticide in the family of chemicals called neonicotinoids (Felsot 2001) in the chloronicotinyl subgroup (USDA Animal and Plant Health Inspection Service 2002). It has a mode of action similar to that of the botanical product nicotine, functioning as a fast-acting insect neurotoxicant (Schroeder and Flattum 1984) that binds to the nicotinergic receptor sites in the postsynaptic membrane of the insect nerve (USDA Animal and Plant Health Inspection Service 2002), mimicking the action of acetylcholine, and thereby heightening, then blocking, the firing of the postsynaptic receptors with increasing doses (Schroeder and Flattum 1984, Felsot 2001). Because imidacloprid is slowly degraded in the insect, it causes substantial disorder within the nervous system, leading in most cases to death (Mullins 1993, Smith and Krischik 1999).

Imidacloprid is considered to have low to moderate mammalian toxicity (Mullins 1993), largely because it does not bind nerve receptors in mammals sufficiently to trigger nervous activity (Felsot 2001). The selective toxicity of imidacloprid is perhaps best illustrated by its use in flea treatments approved for cats and dogs. Advantage® is applied directly to the animal's skin; this preparation carries very little, if any, risk to the animal or to the people, including children, who may handle the animal (USDA Animal and Plant Health Inspection Service 2002). Chronic (repeated dose) toxicity studies have demonstrated that imidacloprid is not carcinogenic and is not mutagenic and demonstrates no primary reproductive toxicity (Mullins 1993). In studies of metabolic fate in rats, imidacloprid was rapidly absorbed and eliminated in the excreta (90 percent of the dose within 24 hours) with little bioaccumulation (0.5 percent of the dose after 48 hours) and no biologically significant differences occurring between sexes, dose level, and route of administration (USDA Animal and Plant Health Inspection Service 2002). Imidacloprid is an insecticide exhibiting both systemic and contact activity. The spectrum of activity primarily includes sucking insects (aphids, whiteflies, leaf and plant hoppers, thrips, plant bugs, and scales), many Coleopteran species, and selected species of Dipterans and Lepidopteron. Although scales are listed, it has not been consistently proven to be effective for EHS control. Activity has also been demonstrated for ants

(Hymenoptera); termites (Isoptera); and cockroaches, grasshoppers, and crickets (Orthoptera). No activity has been demonstrated against nematodes or spider mites (Mullins 1993). In spider mites, imidacloprid has been demonstrated to cause an egg-laying enhancement (James and Price 2002). Since spider mites can be a problem in hemlock, any imidacloprid-treated tree should be carefully monitored for increases in mite populations.

Little is known about the biotransformation and bioactivity of the metabolites of imidacloprid in hemlock. What is known is that trunk-injected imidacloprid generally requires a week or longer to provide adelgid control, with protection lasting for up to 2 years (Tater et al. 1998, Silcox 2002). The soil injection or soil drench methods of imidacloprid treatments take several months for translocation to occur but provides better consistency in treatment efficacy when compared to stem injections.

Foliar Sprays

This method of treatment can be effective in situations where there is access to the trees with ground spraying equipment, including pumping trucks with high-pressure hoses, and the entire crown of each tree can be saturated with the spray (Evans 2000). It is necessary to reach all areas of individual trees to provide complete control. The potential for spray drift contaminating surface waters is extremely high, and thus there are concerns for non-target effects, making this alternative unadvisable adjacent to areas with surface waters. This method is more practical for treating horticultural or landscape trees, like the hemlocks found at Camp Round Meadow.

Treatment with horticultural oil will reduce both HWA and EHS populations if applied at the right time. Life stages of EHS overlap throughout the summer but are likely to have a large emergence of crawlers around mid-May to mid-June. Monitoring for crawlers is necessary for applications to be effective and the addition of a 5% solution of Talstar®, a pyrethrum (Bifenthrin) based insecticide may provide optimum control and require fewer treatments. Oil sprays are effective against all life stages of HWA as long as saturation of the woolly masses occurs. Treated trees should continue to be monitored and re-treated as necessary.

RECOMMENDATIONS

Ground spraying of individual trees with a 2% solution of horticultural oil and 5% Talstar® solution at the Camp Round Meadow area is recommended. Hemlocks at Round Meadow are generally in moderate health, with light EHS and moderate HWA. This treatment will reduce both HWA and EHS populations. Treatment timing should target peak EHS crawler emergence to the extent possible which is estimated to be sometime in mid May to mid June. A second treatment this fall may be needed and populations of both insects should continue to be monitored.

At Hemlock Road and Bear Branch areas, HWA populations are very low and EHS is very high. With treatment options comes the potential for non-target effects; land managers must balance the risk of these effects with the potential benefits that come with the control of the HWA and EHS. Although broad spectrum insecticides could be injected into the soil around the base of these trees, the risk of soil leaching in these riparian areas is of concern and therefore not recommended. Poor tree health in these areas is not contusive to tree injections and is not recommended. Ground spray treatment of individual trees is not recommended because the contamination risk of the nearby stream would be high.

Having had two consecutive cold winters in the region may provide some relief by reducing pest densities and allowing a reprieve for some hemlocks healthy enough to recover. Should this prove to be the case, tree injections will again become a viable treatment option in riparian areas. Continued monitoring of tree health and pest conditions in throughout the park is recommended.

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United States Department of Agriculture | Forest Service | Northeastern Area State & Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: May 5, 2004

Mr. Mel Poole
Superintendent
USDI National Park Service
Catoctin Mountain Park
Thurmont, MD 21788

Dear Mr. Poole:

Enclosed is the biological evaluation of hemlock woolly adelgid (HWA) and elongate hemlock scale (EHS) at Catoctin Mountain Park. These exotic pests and the drought of 1999-2000 are the primary cause of hemlock decline throughout the park.

HWA populations are generally low at this time with the exception of the Camp Round Meadow area where HWA is at moderate densities. The reduced vigor and nutritional quality of the hemlocks in poor health is not conducive to high survivorship and fecundity of adelgids and normally we would expect to see some recovery of trees. Unfortunately, EHS tends to thrive on stressed hemlocks and populations of this pest are currently flourishing throughout the park.

In the Hemlock Road and Bear Branch Creek areas where hemlocks occur near streams, soil injection of systemic insecticides or foliar sprays are not viable options due to the risk of stream contamination. Likewise, poor tree health in these areas does not make them good candidates for successful control of these pests by using tree injection methods. We therefore have no treatment recommendations for the hemlocks in these areas and suggest some consideration be given to preparing a rehabilitation plan involving tree replacement with other species if warranted.

We recommend treatment of infested hemlocks at Camp Round Meadow to control HWA and EHS populations. Control of these pests could be achieved by spraying trees with a solution of 2% horticultural oil and 5% Talstar®. Treatment timing should target peak EHS crawler emergence which is estimated to be sometime in mid-May to mid-June in your area. Our staff can assist your resource managers in monitoring crawler emergence prior to treatment.

Please contact Brad Onken (304-285-1546) if you have any questions concerning this biological evaluation.

Sincerely,

JOHN W. HAZEL
Field Representative MFO

Enclosure

Cc: James Voight, CMP
Jil Swearingen, CUE
Noel Schneeberger, AO